Informatics: The Methodological Magpie

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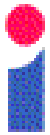

Different Views of Informatics

- Informatics as science.
- Informatics as engineering.
- Informatics as mathematics.
- Informatics as art.

Informatics as Science

- What is the nature of computation & information?
  - A "science of the artificial" [Herb Simon]
  - Others: economics, linguistics, sociology,...
- Experimental studies of algorithms, architectures and systems.
  - Pose hypotheses and test them.

Informatics as Engineering

- How can we build useful ICT products?
  - Design, development, deployment and maintenance.
  - Hardware and/or software.
- Still make and test claims.
  - This software engineering methodology facilitates fast development of dependable systems.
  - This programming language eliminates certain kinds of bug.

Informatics as Mathematics

- What are the fundamental properties of algorithms?
  - Formulate and prove theorems:
    - Complexity of algorithms.
    - Verification of programs.
    - Fundamental limits of computation.
- Theorem as hypothesis; proof as evidence.

Informatics as Art

- Isn't this neat?
  - Building fun systems for their own sake.
- This will change the way you think.
  - Computers doing things you thought impossible.
- "Science in the making" [Bruno Latour]
  - Messy process of proposing, arguing for and convincing others of scientific theories.
  - Involves emotion, polemic, taste, opinion, politics, skulduggery, …
  - Eventually, becomes settled science.
    - Hacking matures to technique.

Which View is Correct?

- Widely different views strongly held.
  - Researchers tend to see just one or two of these views.
- In practice, Informatics is a mixture.
  - Hacking throws up new ideas.
  - Theory cleans them up.
  - Engineering turns them into dependable systems
  - Experimentation tests their scope and limitations.

Wide Range of Methodologies

- Mathematics in theoretical research.
- Science in experimentation.
- Engineering in system building.
- Managerial in project development.
- Art (hacking) in exploration.
- Social science in usability and interfaces.
- Other disciplines in applications,
  - e.g. cognitive science, systems biology,…

Each methodology has its limitations

Exercise: Which Methodologies?

- Which methodologies will you use in your research project?
- How will they be used?
- Will they be combined?

Methodologies in Informatics

- Informatics inherits methodologies from many other disciplines.
- Inevitable to use methodology of a discipline to evaluate a computational model in that discipline.
- But more than this.
  - Due to multi-faceted nature of Informatics.

Engineering

- Especially in hybrid: software/hardware systems:
  - Computer hardware: electronics.
  - Robotics: mechanical and electronics.
- Computer modelling: use engineering method to evaluate model.

Mathematics

- Ubiquitous in theoretical computer science.
  - definitions, theorems, proofs.
- Infer properties of algorithms:
  - complexity, termination, correctness, completeness.
- Build formal framework:
  - logical theory, classification, grammar, FSM.
- Prove property of generic task,
  - e.g., NP completeness of tautology checking.

Statistics & Probability

- Statistics: used to analyse experimental results.
- Probability: used to model uncertainty:
  - In machine learning, e.g., neural nets.
  - In knowledge representation.
  - In modelling systems,
    - e.g., stochastic model checking for system biology or computer failure.

Psychology

- Cognitive modelling:
  - compare model to human/animal behaviour.
- Human/computer interaction:
  - measure usability of system.

Philosophy

- Conceptual analysis:
  - Clarify the nature of tricky concepts, such as agency, time, belief, meaning, causality, obligation, etc.
- Philosophical logic:
  - Represent commonsense knowledge including time, belief, obligation, etc.
  - Temporal logics also used in model-checking of computer systems.

Linguistics

- Grammars of natural languages:
  - Used for speech and written language generation and understanding.
- Conceptual analysis:
  - of the nature of linguistic utterances, objects and processes.

Sociology

- System development:
  - To understand how teams of developers interact and are best organised.
  - To understand how errors arise.
- System deployment:
  - To understand how new technology is received by its intended users.

Biology & Medicine

- Neuroscience:
  - How the brain can be modelled.
  - Brain-inspired computation.
- System biology:
  - Evaluation of computer models, e.g., of cellular interactions.
- Evolution:
  - Evolutionary computing.

Law

- Misuse of computers:
  - viruses, hacking, data security.
- Intellectual property rights:
  - Patentability of programs is hot issue.
- Legal liability:
  - For computer failures, etc.
- Conceptual analysis – using case studies.

Miscellaneous Disciplines

- Business studies:
  - Use of computers in business.
  - Computers as a business.
- Economics:
  - Faithfulness of computer models.
- History:
  - Of computing
- Art criticism:
  - Quality of computer graphics.

Summary

- Informatics is a science,
  - But also it is engineering, mathematics and art.
- Each view brings its own methodology,
  - And all are needed,
  - Since they complement each other's limitations.
- Informatics borrows methodologies from just about every discipline.